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the century which had seen the rise of English maritime power, we come to the most valuable account of "one of the few serious attempts to put in practice the strategical dream of attacking England through Ireland," the failure of which Mr. Corbett attributes to "the yet unmeasured power of the sea" and to "two sagacious soldiers who felt the mastery it gave."

After Cezimbra Road the narrative of events closes fittingly with the tragic chapter called "The Last of the Galleys" enabling Mr. Corbett to end his work on the Tudor navy as he began it, with strong emphasis upon the transition from the warship of the Middle Ages to the type which pointed to Nelson and Trafalgar. It is pleasant too that the galley should have emerged from this last trial, if not with success, yet with high honor to itself and above all to Spinola, whose greatness, however, only served to reveal with increased conclusiveness the superiority of the northern school.

Though the narrative proper ends with the Dutch bullet that stretched intrepid Spinola upon his galley deck, there remain two valuable chapters discussing the results of the long war and the navy as Elizabeth left it. "In spite," Mr. Corbett concludes, "of all that seems at first sight so old-fashioned in the instruments and ideas which Drake and his successors used, they differed only in design, and that in no large degree, from those with which Nelson brought the art to its zenith."

While it is possible that future writers may modify some of Mr. Corbett's verdicts, they will not alter the fact that he has written an excellent volume upon a period greatly in need of illumination. Amphibious as the heroes he has portrayed so well, he proves himself, whether describing operations of war by land or sea, equally instructing, stimulating and brilliant.

W. F. TILTON.

*Thomas Harriot, the Mathematician, the Philosopher, and the Scholar.*

developed chiefly from Dormant Materials, with Notices of his Associates, including Biographical and Bibliographical Disquisitions upon the Materials of the History of 'Ould Virginia.' By HENRY STEVENS of Vermont, F.S.A. (London: Privately printed. 1900. Pp. xii, 214.)

THE editor of this book, Mr. Henry N. Stevens, tells us that the whole text has lain "printed off" since 1885; and the printing was commenced in January, 1878. Nevertheless, its contents have not been forestalled. Nothing has appeared about Harriotts, since the earlier date, more important than the good but unoriginal article in the *Dictionary of National Biography* and three pages of critical estimate in the second volume of Dr. Moritz Cantor's *Vorlesungen über die Geschichte der Mathematik*. During the eight years of its printing, this volume grew by the accumulation of successive discoveries, and thus cannot be quoted as containing any definite opinions, as the author himself warns us. "Repetition, and perhaps some contradiction, are acknowledged. But meandering thoughts and ill-digested narratives, though tedious, are not criminal." They are not only not criminal, but to a careful student, they

are more valuable than a unitary working-over of them might be. Certainly nothing in this little volume is in the least tedious. To one condemned to pass a large proportion of his time in reading the writings of German scientists who glory in writing awkwardly, and have carried that art to its last pitch of perfection, a style like this is simply delicious. Though Stevens uses the spelling "Harriot" throughout, yet in the last testament appended to this essay, the name at every occurrence appears as Harriotts. An *s* very easily gets dropped from the end of the name of a writer, because it so often occurs in the possessive case; and doubled consonants in names were usually made single in latinization; as Copernicus for Koppernik, and Keplerus for Keppler. In the signature to a letter, printed as "Harriote," a final *s* may have been inadvertently taken for an *e*; *s* final, in much of the chirography of that period, looking a good deal like a modern *e*.

Our acquaintance with the man has hitherto been limited to a skeleton biography and a few slight notices, together with a treatise upon algebra based upon his papers but drawn up by another person. How is this acquaintance improved by the new publication? First, we are now presented with a speaking portraiture of his character and life. Next, Harriotts' will had eluded more than one accomplished huntsman for such documents; but from the moment when our Vermonter entered upon the search the snuggest of *catiches* could no longer secure it from being drawn to light. So here it is, printed in full; and it affords us, aside from more general information, certain significant hints regarding the contents of the scientific papers the testator left behind him. Thirdly, the first half of a letter to Harriotts relating to his observations in astronomy has, for a century, figured in the history of that science, having been unearthed, talked about, and ultimately published, by Baron Franz von Zach. The original is presumed to be still at Petworth Castle. But Stevens found the other half of the letter (bearing the signature of a person never suspected as its writer); and everybody will pronounce it to be much the more important half. Fourthly, Harriotts, in his will, directed that N. Thorperley should receive his "mathematicall writings . . . to the end that after hee doth understand them hee may make use in penninge such doctrine that belonges unto them for publique uses as it shall be thought convenient by my Executors and him selfe;" after which the papers were "to be putt into a convenient truncke with a locke and key and to be placed in my Lord of Northumberlandes Library and the key thereof to be delivered into his Lordships hands." But Stevens produces facts which go far to indicate that Thorperley was not only utterly indolent in the performance of the duty so imposed upon him, but was a person of the worst judgment in regard to such duty, and furthermore, was by no means as appreciative of what was entrusted to him as it is desirable that a literary executor should be. And to those facts Stevens adds others which prove that von Zach, who next went through the papers, did so quite cursorily, to use no harsher word, while by eliminating seven-eighths of them (which went to the British Museum) he rendered it difficult for

other mathematicians who subsequently examined them (even had they been animated by a historical spirit which did not belong to their generation), to ascertain what the real historical value of the writings might be.

Mr. Stevens thinks that he has given strong grounds for believing that great injustice has been done to Harriotts as a mathematician ; but this cannot be admitted. There are many mathematicians who delight in conception but shrink before the labors of parturition. If Harriotts was not one of these, he was, at any rate, prevented by other business from publishing his discoveries, of which, however, he seems to have made no secret. Scientific men, not wishing to be led astray from their own studies into difficult questions of the history of science, have adopted the handy rule that priority of publication must decide to whom a discovery belongs. This is just enough ; for if a man does not take the necessary trouble to give the world his own account of his discoveries, how does he merit a crown of glory for that which he has done for his own satisfaction? Justice, however, is not the question for the historian of science. He wishes to know whether, at a given stage of intellectual development, a given generalization was within the reach of a whole class of minds or only of one hero, and what form it would take in different minds. That Harriotts followed Viète in algebra is unquestionable. His terminology and notation prove it ; and he himself acknowledges it. It is true that some of his scholars speak as if he had been in possession of some of Viète's methods before the latter published them in 1591 ; and this may be. It is hardly likely that his papers would show whether it were so or not. The achievement for which he has usually had the credit was the bringing all the terms of an equation to one side, and the regarding the quantic so obtained as a product of linear factors some one of which must vanish and furnish the solution. To have done this in the sixteenth century implies a high order of mathematical power. In addition to this, he is usually credited with the common method of finding rational roots of numerical equations, and with the general idea of resolving such equations by successive approximations. That is much. It is enough, in the judgment of most critics, to place him in the second rank of mathematicians—corresponding, let us say, to the rank of Horace, of Pope, of Wordsworth, of Lamartine, among poets. But this does not satisfy Mr. Stevens, who wishes him to be placed in the front rank—in the rank corresponding to Homer, Dante, Shakespeare, Goethe. But this is too much ; and Mr. Stevens simply does not know what it is that he asks. He reminds me of the fisherman who asked to have his wife made pope. Harriotts plainly did not belong to the mental gender of the gigantic generalizers. He is said to have been the first to obtain the area of a spherical triangle ; and such is the sort of mathematical discovery which we might hope that the examination of his papers would bring to light. Certainly the Savilian Professor who reported about 1788 (not in 1802) against publishing some of the manuscripts, however sound the advice may have been under the particular circumstances existing at that juncture, gave an absurd reason for it when he said that they “ could not con-

tribute to advance science." So the science of arithmetic was not advanced by the translation of the Rhind papyrus;—but the history of the human mind was greatly advanced. Rigand's later discussion of the question was too much in the same spirit. Merely for their probable mathematical interest, the papers would certainly repay the labor of examination.

Mr. Stevens rather timidly puts forth the suggestion that Harriotts invented the telescope before Galileo. But Galileo is not now regarded as the first inventor of the instrument. Stevens does not seem to be aware that Leonard Digges's *Pantometria* first appeared in 1571, and that the combination of lenses there described could hardly have been actually made by an intelligent experimenter without his discovering the telescope. Now we know that Harriotts in 1585 was showing the Indians in Virginia wonderful things with "perspective glasses." By a "perspective glass," at a somewhat later date, at any rate, was always understood a telescope; and in strictness nothing else ought to be so called. Still, even supposing that Harriotts's perspective glass was a *camera obscura*, which Baptista Porta had described in 1558; yet when we find him making "perspective trunks," which unquestionably were telescopes, in 1609, only about a year later than Hans Lippersley's application for a Dutch patent, and remember his habitual neglect to claim discoveries, for which his correspondents reproach him, it certainly does seem most probable that in examining the apparatus of that supposed *camera obscura*, he had observed phenomena which could not but lead a mind like his to making a telescope. It would be well worth while to examine his papers if only to find out how that was.

He observed the satellites of Jupiter so nearly at the same time as Galileo, that his papers ought to be carefully searched, in order to ascertain the precise date and circumstances of his first seeing them.

Moreover, it appears that Harriotts was the first of the series of English atomists, a series embracing minds as widely discrepant as Harriotts, Cudworth, Boyle, Shaftesbury, Hartley, Dalton, Maxwell. In other points, his philosophical opinions were original; but they remain obscure. This makes another urgent reason for a re-examination of his remains, to be followed, this time, by publication. America owes as much to Harriotts as England does. Is she not as able to afford the ways and means—in learning and in money—for such a publication as the mother country, who has spent so much, and so gloriously, upon history?

But, of course, until those papers shall have been examined, nothing at all can be claimed for Harriotts on the mere strength of probably exaggerated remarks by enthusiastic scholars addressing him in letters. Thus one of these, early in 1610, having just read Kepler's *De Motu Stellae Martis* says, "I remember long since you told me as much, that the motions of the planets were not perfect circles." Now, to have had that idea was certainly remarkable; but there is a million miles between that and Kepler's discovery, which Harriotts could not possibly have made, since he was not in possession of Tycho's observations.

But Mr. Stevens's book makes it clear to us that the worth of the man did not lie in his mathematical and scientific genius, rate it as high as you can, but in his fine character, his perfect fidelity, his freedom from personal views. His will evinces the same business-like care with which, through life, he had performed all those of his duties to which selfishness could not urge him.

The volume is pretty. It is not surpassingly so; but then, when the printing was begun, we were not yet tired to death of the rather fanciful imitation of the sixteenth-century Roman type. There is an index which seems to have an entry for about every fifty words of the text. I forgot to mention that there is interesting information in the book about de Bry, Jacques LeMoyné, Captain John White, William Sander-son, Robert Hues, and others. But I am too ignorant of American history to venture upon that ground.

C. S. PEIRCE.

*Richelieu and the Growth of French Power.* By JAMES BRECK PERKINS, LL.D. (New York and London : G. P. Putnam's Sons. 1900. Pp. xiii, 359.)

ABOUT fifteen years ago Mr. Perkins presented studies of the great Cardinal in his *France under Mazarin*. Although he modestly called these a "Review of the Administration of Richelieu" they treated the subject almost as extensively as the present work, but with less emphasis on the personal side of Richelieu's career. The biography is not to be considered a mere rewriting of the same material. A comparison of the two accounts shows that Mr. Perkins has approached the subject with opinions substantially unchanged, and yet with his thought of it controlled by additional years of investigation and reflection. Indeed, it is remarkable to how small an extent there are verbal similarities in the statement of what is necessarily the same matter. Since his previous work the publication of two volumes of M. Hanotaux's *Histoire du Cardinal de Richelieu*, a work which Mr. Perkins himself says "will remain the permanent record of the great Cardinal," has enabled Mr. Perkins to compare his own results upon the subject as far as 1618 with those of the distinguished French historian and statesman. The conception of the man in the pages of the two writers is not dissimilar. Upon one's first reading of Mr. Perkins's description of Richelieu's earlier career one feels that he has made the transformation of the Cardinal's conduct too abrupt at the time of his accession to power. The ambitious intriguer, who uses the bishopric of Luçon merely as a stepping-stone, and who is not above taking the attitude of fulsome and servile flattery towards the Queen-Mother, suddenly appears as the farsighted statesman, who was selfish, it is true, but only because he had determined to be himself the instrument of carrying into effect his designs. A second reading shows this to be a carefully worked out conception of Richelieu's career. Hanotaux puts the matter in this way: "Jusque-là, il avait marché, contraint et courbé, dans les avenues de l'ambition et de l'intrigue. A peine au pouvoir, sa taille se redresse," etc.